



BPRAC Meeting  
February 12-13, 2004

# **Biological and Physical Research Advisory Committee (BPRAC)**

**NASA Headquarters  
Washington, DC**

**February 12-13, 2004**

**Minutes**

**Bradley M. Carpenter  
Dr. Bradley M. Carpenter  
Executive Secretary**

**Kenneth M. Baldwin  
Dr. Kenneth M. Baldwin  
Chair**

### **Welcome and Introduction**

Dr. Kenneth Baldwin, Chairman of the Biological and Physical Research Advisory Committee (BPRAC), opened the meeting and welcomed members, noting it was an exciting time of change within NASA and for the BPRAC, which is experiencing significant turnover occurring at this time. New members, Dr. Eugenia Wang and Dr. Charles Oman, were welcomed as well. Dr. Baldwin recognized departing BPRAC member, Dr. Alex McPherson, for his ten-year stint and outstanding contributions, and also expressed gratitude to Dr. Ray Bula and Dr. Bradley Carpenter (retiring as Executive Secretary).

### **Report to the BPRAC**

Dr. Bradley Carpenter provided an update on BPRAC recommendations from previous meetings. Dr. Carpenter especially acknowledged Dr. McPherson for his hard work and support, and his achievement in using space-grown crystals to obtain the highest resolution virus structure yet reported. He also thanked the committee for their patience in this time of great flux in NASA. The first significant issue was the restructuring of the subcommittees of the BPRAC: it had been recommended previously to continue the Space Station Utilization Advisory Subcommittee (SSUAS) and Commercial Advisory Subcommittee (CAS); these will be rechartered for two years, and other subcommittees will be determined as program content decisions are made. The second significant recommendation was to review and discuss the plan for the International Space Station Research Institute (ISSRI); the response to which would be covered by Dr. Mary Kicza later in the meeting. The third recommendation concerning research partnership centers, reconsidering their elimination, was also to be covered by Dr. Kicza. Finally, a last recommendation to consider the cost of hardware development, to understand better the sources for project costs, and to better understand how different developers compare, is currently under consideration with respect to payload/hardware development and project classifications.

### **OBPR Program Review**

Ms. Mary Kicza, OBPR Associate Administrator, presented the Office for Biological and Physical Research (OBPR) overview, and began with a recent history for the benefit of new members. In Spring 2002, a Research Maximization and Prioritization (ReMaP) task force was chartered in response to an International Space Station (ISS) cost and management evaluation, suggesting that ISS could benefit from reprioritization of research. The task force looked at the entire portfolio and suggested relative priorities for greatest scientific impact. ReMaP reaffirmed the value of ISS for meritorious research and indicated ISS's essential role in the new exploration regime. In Fall 2002, OBPR briefed the NASA Advisory Committee (NAC) on the response to ReMaP recommendations, and placed ReMaP in strategic context, and re-stratified research priorities. The NAC endorsed the response to the ReMaP but emphasized that an overarching framework was needed to better characterize OBPR's research portfolio. BPRAC responded aggressively to ReMaP and NAC follow-on recommendations. Through Fall 2003, OBPR developed a ten-year research plan, and developed the Enterprise Strategy. OBPR then initiated a process to regularly examine priorities for ISS research manifests. Beta tests have been performed to evaluate the process of prioritization- the first round was internal, and the second test will be external (in the Spring OBPR intends to pull in people who have a bigger picture perspective).

*President's Vision*

Four key tenets of the President's new lunar and Martian initiative were presented:

- NASA will implement and sustain an affordable robotic and human program to explore the Solar System (SS) and beyond.
- NASA will extend human presence across the SS with a return to the Moon by 2020.
- NASA will develop innovative technologies, knowledge and infrastructure to support exploration.
- NASA will promote international and commercial participation in furthering the goals of the exploration initiative.

*Current goals (environment) in response to the President's vision*

- Return to Flight of the Space Shuttle, to be retired after ISS assembly is complete.
- Complete the assembly of the ISS.
- Continue research on ISS through 2016 with a specific emphasis on human research and countermeasures.

The FY05 budget was presented, with the budget running at about a \$950M per year level. OBPR must determine the appropriate spread of monies across Agency activities.

An immediate action has been taken on the delayed ISSRI procurement due to the impact of the President's vision. The contract start has been delayed for a minimum of one year in order to assess the need for an ISSRI. An internal assessment is due in June 2004. Dr. McPherson asked if there were an inclination to go forward with the procurement. Dr. Kicza responded in the negative, noting that OBPR wants to have the team look at the changes to the statement of work (SOW) associated with its more focused research agenda before a decision is made.

*Current OBPR considerations and activities*

OBPR has sent out a Dear Colleague letter to inform others of the President's vision and its implications for the OBPR community. The refinement of the Bioastronautics Critical Path Roadmap is under independent external review. The Forward Work Plan includes the establishment of a new Code T and working out the particulars of its relationship with Code U. A robotic Recon mission is planned for a 2008 launch, and OBPR will participate in subsequent efforts. Dr. Baldwin remarked that we keep hearing "one NASA," not just stovepipes. Dr. Kicza agreed that this new aspect of NASA unity was definitely real. OBPR is also examining its current research portfolio, pondering specific deliverables for a specific near-term timeframe and looking at ways to solicit research give the current environment. How much fundamental research do we retain in the portfolio and in what venues? OBPR will transition the ISS manifest to address needs for exploration. OBPR is working very closely with the ISS as it develops the FY06 process. Dr. Borer asked about the fate of previously approved projects as these things change. Ms. Kicza replied that OBPR is trying to establish a rational transition strategy to maintain a good relationship with the community. OBPR is very sensitive to the issue. Dr. Oman asked about possible new approaches to solicitation. Dr. Kicza mentioned a range of approaches, from directed, managed research to broad NRAs, as OBPR has been done in the past. It may be more akin to a DARPA approach, with focused teams of experts with typically higher funding amounts, specific deliverables and aggressive milestones. It will be a mix, to keep the competitive spirit alive. Peer review will be retained, but with attention to

timetables. OBPR is also working very closely with Mr. Gary Martin, Space Architect, and is working with the Agency as the Strategic Plan is modified over the coming year. Objectives may be refined in this context. Dr. Kicza strongly encouraged BPRAC's engagement, and asked BPRAC to be in the driver's seat in the development of the next strategic course, adjusting OBPR objectives in the near term, addressing portfolio balance, flight- vs. ground-based research, strategic vs. fundamental research, and how to communicate the plans of the OBPR to the Agency and the community at large.

#### *Summary of OBPR overview*

An exploration agenda does not mean "no science." OBPR is critical to enabling the exploration agenda; the innovations will be beneficial to Earth as well. This is not a race, but a journey, and is about human destiny, and explorers to come. College students today are likely the ones who will walk on the moon, and elementary students may embark on a Martian journey. It's not about us, but about them. Dr. Baldwin asked for any thoughts about restructuring subcommittees, adding that he sensed the subcommittee structure has been underutilized- they are the ones who feel the pulse on items like balance of the portfolio. Dr. Kicza remarked that there is an option to sustain them as they are: OBPR needs to address the organizing questions and wants to retain the SSUAS and CAS. The decision is on hold to determine what makes sense in light of the deliverables. Dr. Borer suggested thinking about limited term task forces for needed input on specific issues at the right time. Dr. McPherson asked about transportation opportunities to and from the ISS (2010-2016) Dr. Kicza replied that OBPR is considering the problem, also with international partners. There is as yet no acceleration in the ISS process. Dr. Gross asked if there were any problems with earmarks and changes in strategy and if there was anything in the works to prevent counterproductive earmarks. Dr. Kicza replied that this concern should be on the table to address to the Agency. Dr. Baldwin suggested that the BPRAC offer comments on providing a careful transition strategy for the OBPR research program as it focuses more closely on an exploration agenda, and must weigh in on the value of a limited-term task force concept as the transition moves forward.

#### **Implementation of the Administration Vision**

Mr. David Schurr presented the Administration's *Renewed Spirit of Discovery* document, detailing the President's vision of exploration. "Sustainable, affordable and flexible" was the key phrase. Much of the plan will be subject to revision. The policy goals were delineated, centering on the concept of sustained and affordable human/robotic exploration to the Moon, Mars and beyond. The guiding principles were presented. While the Moon is the first destination, it will also be used as a proving ground for expanded exploration. The basic roadmap has been laid out; it is not rigidly set, but it identifies key elements. Near-term projects are already well under way. The strategy will be predicated on long-term affordability. The initial strategy has been to compare budgetary needs to an Apollo-style program to determine whether a credible approach is in place. Shuttle retirement frees up a large amount of funding. Dr. Baldwin asked: where are strategies for operational crew numbers on the ISS? We need to enable the human presence in space (they are the guinea pigs). Mr. Schurr replied that effectively, there will be a return to a crew of three as soon as RTF is accomplished. Final crew numbers are to be determined (note: on February 17, Russia announced a manufacturing plan to build a 6-person Soyuz vehicle). There is no date on the table at the moment. Dr. Kicza interjected that crew size and increment duration will be affected by OBPR requirements.

Dr. Baldwin noted that there were a lot of debates at the NAC level to try to get a handle on the development of the ISS; the science community has never accepted the “core-complete” concept. The strategy now seems to be “program-complete,” which is encouraging and good news for the science community. Mr. Schurr responded that the research community will have an opportunity to influence the research on the ISS after completion. Organizational changes were briefly delineated; creating new offices, aligning ongoing programs, experimentation with new ways of doing business, but with no real changes in the biological/physical parameters of the program. Budget estimates for FY05 are in progress. ISS is about halfway to international partner core-complete. The crew is now restricted to two, with status on hold, relying on international partners. Dr. Baldwin asked what is the real rate-limiting step to Return To Flight? Who gives the blessing to launch? Code M has these answers, but the general impression was that the Space Flight Enterprise, through Mr. Readdy and the External Review Boards, up through the ranks of the Agency, provided this approval. A question was raised on critical consumables; this issue is continually under review. The ISS will be used as a stepping stone to support exploration goals, and NASA intends to meet its obligations to international partners. Lunar exploration will be undertaken to enable sustained human/robotic exploration of Mars and more distant destinations in the SS. The first human expedition is estimated to be in the 2015 timeframe, to use the Moon as a testbed for Mars; there is no real push to have a permanent human presence on Moon. Robotic exploration of Mars is in progress. The Jovian moons mission, outer planets missions and new space telescopes are part of this preparation. During the next decade there will be two robotic missions to the Moon, five to Mars, and three space telescopes. Fundamental technology developments in communications, materials, propulsion systems, etc. must also be achieved. Ultimately, Mars is the destination; it is not on a roadmap because human mitigation strategies are still in development. NASA may visit an asteroid before humans go to Mars. A new crew exploration vehicle (CEV) will be built to transport crews (under the Project Constellation aegis). A first test flight is projected for 2008, fully operational by 2014. Level 0 and 1 requirements are being examined. Opportunities with international partners and commercial partners are also being considered. Dr. Baldwin asked if commercial partners were up to the challenge. Is a prize being awarded? There is a set of centennial challenges, supported by approximately \$80M over 5 years, to identify specific challenges and accomplish certain goals. There is a lot of capability in the commercial launch world; NASA is essentially asking these corporations to demonstrate that they can be providers. The goal is to divide crew and cargo lift as much as possible. Providing cargo carriers makes more sense in the commercial arena. BPRAC and OBPR will be instrumental in developing the details of the roadmaps. Dr. Gross asked if there was any room for research modules in future shuttle flights. An audience member commented that there are some science racks due to be on the next flight. Can we piggyback science on shuttle flights? An attendee commented that the focus on ISS completion does not preclude science, there are 25-30 shuttle flights left; the realities are going to play out and we will do the best we can. Another attendee commented: does assembly complete include installation of research facilities? Mr. Schurr responded, yes, we must decide which ones. Dr. Baldwin noted there is a concern that this is an ambitious vision, and the question is Congress ready, are the people of the country ready, could we get the rug pulled out from under us? What about a regime change in November? Will earmarks become rampant in the process? Mr. Schurr replied that the Aldridge Commission is discussing this issue at length; the exploration vision is neither Republican nor Democratic. The Agency has long been in need of a focus, pointed up by the Columbia incident-what do we want to do with humans in space? The commission has been discussing ways to

make the vision independent of political change. Dr. Wang commented that it is important to be able to report the real gain of the exploration vision to the common person; NASA also needs a concrete goal to attract the support of the science community. Shuttle assembly missions must also include a human endurance component to develop countermeasures that are critical to the exploration pathway. Mr. Schurr agreed that this was a difficult question; NASA needs to get the balance right.

### **Administration Perspective and Priorities**

Mr. Jason Rothenberg of the Office of Management and Budget (OMB) presented the budgetary priorities. The role of OMB is to fill in the details engendered by visions; OMB tries to start at zero each year and work its way up. Analytical scrubs of budgetary items are reconciled with political reality. Three top priorities are strengthening homeland security (HS), defense, and the economic recovery. A \$521B deficit is projected for 2004. OMB is trying to reduce this by half in 5 years, resulting in tough choices. The overall budget increase is effectively 0.5% for non-defense and non-HS programs. The R and D budget (at a record high level) is mostly for DOD and HS. The rest of the government received a 2.3% increase overall, much of this going to NIH. There is a lot of concern about continuing R and D; we don't want to move backwards. The R and D criteria and the Program Assessment Rating Tool (PART) are works in progress. R and D criteria started from an effort at Department of Energy (DOE) to separate the tasks appropriate to industry and government. Three assessment criteria are relevance, quality (peer review), and performance. NASA will be held to these criteria. The PART takes this one step further; it is comprised of a series of yes and no questions to evaluate a program, and looks for benchmarks. Basic research is hard to quantify; we measure output by looking at process, what does the National Academy of the Sciences (NAS) think, what does the community think? Applied research is easier to quantify because there is a concrete goal and we can define marks of progress. BPRAC could help OMB think through these issues. \$16.2B has been requested for NASA to implement the vision on an affordable and sustainable basis. New money is an increase of \$1B, but in reality it is a \$12B reallocation. NASA needs a lot of dollars in 2005. OBPR increased by 6%, but with tough realignments. OMB is trying to protect NASA's budget in the outyears to protect exploration. NASA's increases are effectively locked in over the next 6 years. Future initiatives can be fit into the billion-dollar threshold and OMB will probably support new initiatives, as long as some other project can be closed out. There is some substantial gray area in the NASA budget, and in OBPR as well. There will be ongoing dialogue with NASA, OMB, Congress, etc., as the budget allocations are brought along. OBPR has a tough road, lots of new plans, lots of constituencies to convince. Mr. Rothenberg invited active dialogue in this process. Dr. Gross asked how international partners were factored in. Mr. Rothenberg replied that financial contributions were considered and were heavily considered in ISS allocations, recognizing there will be some reliance on these. OMB tends to ignore earmarks. It is agreed that earmarks limit the flexibility of the agency, but it is not known if there is political will to do more than complain about it. Dr. Borer asked if there were any contingencies built in for international default. OMB can't really plan against it; it must rely on NASA's contingency plans. So far, Russia has responded well and we hope for more cooperation. Dr. Borer asked: what other input is necessary to judge the three criteria. Mr. Rothenberg replied that everything is factored in: GAO, NAS (de facto source of blessing a research agenda). Dr. Oman asked if there were budget opportunities present in delays to RTF. There is room for discussion on this. How much of a RTF delay can be tolerated? How

complete is complete on ISS? This will play out over the next few years. There may be mechanisms to take pressure off the shuttle as new vehicles and partnerships are developed. Dr. Bula commented that space exploration can be a nationwide initiative rather than a NASA initiative- some good research can benefit HS and DOD. Right now the Administrator is very familiar with this concept and has also pushed for relevance to the common person. Mr. Rothenberg agreed but noted that the Administration is trying not to over-promise. Dr. Baldwin asked for insight on how OMB functions- is there an opportunity to invoke wisdom on the constancy of programs through changing administrations? Mr. Rothenberg explained that a change of administration entails a briefing on programs and an attempt to carry the weight of the budget, disconnected from politics; pros and cons of specific projects are presented and one hopes the programs stand on their merits. The best one can hope for is that the new president will leave it alone. Dr. Baldwin commented that science has always been the orphan child of visionary programs; when ISS was in overruns, the science community was greatly affected in an adverse way. Are the numbers right to support and grow the science program? What has changed to make this change? Are there bartering capabilities for NASA to reallocate science monies? Mr. Rothenberg replied that OMB needs proof that the proffered budgetary numbers won't support the science. NASA must show specifics in order to support budget requests, but there is little room for change in the top line. There is always room for trade between programs and Enterprises. Dr. McPherson commented that there is a parallel space program at DOD; does OMB look at the overlap and consider shifting funds between agencies? Yes, but it must be remembered that DOD is easily called away to respond to national security concerns. NASA doesn't want to become overly reliant on what DOD is doing. Dr. Borer commented that he couldn't see how research can be projected any better than it is because research is fundamentally serendipitous- one can't predict deliverables for science. It is not useful to cry for money when one cannot predict such outcomes. The best one can do is to base the projection on the current program- the budget is not so bad. Dr. Gross asked if NSBRI would be receiving increased funds. Mr. Rothenberg replied that Mary Kicza should represent the needs of NSBRI to determine this. Dr. Wang commented that the cultures of biological and technological sciences are very different; how does OMB judge this? OMB needs to keep in mind the split between basic and applied research. PART leaves a lot of room to look at the strategic plan and can help to bolster the program's merit. An attendee exhorted members to read the PART tool at the OMB website. The OBPR has been rated according to the PART- the grade was high in planning and managing, but not high in results because it is hostage to the Shuttle program. NASA is also trying to create its own metrics and trying to better evaluate and rate the effectiveness of the countermeasures program. Mr. Rothenberg agreed that it is a partnership effort to refine better criteria for judgment.

### **Lunch presentation**

Dr. Jan Meck presented an overview of countermeasure research performed at her laboratory at Johnson Space Center.

### **International Space Station Research Status**

Dr. Don Thomas presented the current research status of the ISS. The effects of the Columbia incident have been to limit up- and down-mass capability, reduce crew size, and reduce the  $n$  number for life science investigations. Coping strategies include finishing experiments in progress, and performing additional experiments on reusable materials, e.g., PFMI

(solidification). New experiments have been developed to fly on Progress vehicles. New experiments that require no upmass have been developed and plans are under way to maximize international cooperation (e.g., GCF protein crystal experiment).

For the last flight, 100 kg of experiments were reduced to 13 kg, including a yeast-GAP-1 experiment (response of genes to space flight). This flight was launched on Jan 29 and was docked on Jan 31. Some US training materials have also been launched, such as hardware for payload LAN traffic. Dr. Oman asked which subdisciplines had been successful in Fast Track. Fundamental biology came up with 4 experiments in this timeframe; it was a nooks and crannies game. Lightweight, small volume, no special processing needs seemed to be important criteria for selection. Near-term utilization planning includes flying ISS research on limited Progress and Soyuz flights, even though formal allocation is currently zero. Downmass projects include renal stone experiments, soldering experiments, and tapes. Accommodation status was reviewed. Racks currently on orbit were described and included the Microgravity Sciences Glovebox. Seventy-three investigations have been completed or are underway. The Centrifuge is scheduled for September 2009. A "pre-Columbia" plan has been modified and successfully executed, and utilized 163 crew hours for research. CBOSS is ongoing and will continue through Expedition 8. Crew Earth Observations included "Lewis and Clark" targets. The Expedition 8 status through January includes uninterrupted science operations, a recovery of hardware failure, and FOOT experiments. Other investigations in progress include a hand posture analyzer, renal stone experiments, advanced ultrasound for telemedicine capabilities, SPHERES, interactions (interpersonal factors), journals (isolation behavior study), miscible fluids in microgravity, and Earth knowledge acquired by middle schools. An increment 8 OOS overview was presented. The Cervantes Soyuz Taxi Flight Science program (10/20-28) was briefly described, which included 35 hours of crew participation. The DELTA Soyuz flight will go up in April 2004, an ESA/Dutch-sponsored flight. As 8 type 1 slots became available in an European Space Agency (ESA) centrifuge, a *C. elegans* experiment has been put together with international cooperation. Expedition 9 has been planned; last minute crew changes have been challenging. There are 24 ongoing experiments for the expedition. Dr. Merrell pointed out that the amount of science done on the ISS is a great tribute to Dr. Thomas. There is not enough time to put any new experiments on the Expedition.

#### *Implications of the President's vision for ISS research*

Research will largely focus on human health risks, thus reducing fundamental research projects. The impact on international partners is unknown. Because the Shuttle will be retired and the Orbital Space Plane (OSP) has been cancelled, NASA is going to rely on Soyuz for crew transfer and rescue, and will be exploring potential domestic and international options to fly cargo to and from ISS. OBPR is developing strategies to significantly reduce downmass requirements. The ISS program is out of the "penalty box" budget-wise and can plan for enhancements such as a larger crew size. Dr. Baldwin commented that given the fact the ISS is the primary platform for space research, we are handicapped by the limited capabilities of the ISS and must overcome a lot of inertia to take advantage of what we have, or we must get more clever and aggressive ground-based analogues. In addressing risk, we must also address fundamental problems related to countermeasures for space-induced deficits in human physiology. Experiments on gene chips won't fill the bill in answering these questions. The CEV is still conceptual, so we are probably talking about Soyuz, Japanese vehicles, etc., beyond 2010. Dr. Merrell commented that progress



is pretty good in terms of upmass. The Iranian non-proliferation act (INA) is also a problem. In addition, the ISS's basic *raison d'être* has changed, and the international partners have not been sufficiently apprised of these changes. It is unknown whether a possibility of a second (or more) Soyuz flight per year exists. There was considerable debate on the increase of traffic to the ISS—the Russian space agency needs a 14-month lead time for extra flight requests to get through manufacturing, etc. Dr. Bula commented that the Soyuz and Progress are good for upmass – is there a way to bring back just data? This is a significant obstacle to research on the ISS. There are no significant discussions on near-term downmass capabilities at NASA. Preliminary exploration requirements were delineated and compared against exploration requirements. Microbe cell tissue sciences constitute a significant downmass need. Cargo/crew transportation options were reviewed. NASA is reevaluating requirements for cargo and crew. NASA needs rescue capability and will be dependent on the Russians after the Shuttle retirement. Crew size will remain at two until RTF; afterwards, crew size will be three or multiples of three (Soyuz capacity). NASA and its IPs will determine the ISS configuration for a larger crew. Strategies to reduce downmass were briefly discussed, and budget impacts for forward work were outlined. Dr. Fuller remarked that the INA is a document that the Administration can get around if it chooses to. Dr. Merrell answered that the Administration is going to seek a waiver, with no gaming involved.

#### **OBPR's Role in NASA's Next Steps**

Dr. Howard Ross, DAA for Science, stated that NASA has a \$716M problem and a \$4.8B opportunity to do something special. The intention to focus research and use of ISS on supporting exploration goals does not imply exclusivity; science can be accomplished simultaneously. “Conducting ISS in a manner consistent with our international partners” is an uncertain phrase. Space exploration beyond low Earth orbit (LEO) and the Moon is meant to further science and to test new approaches for technology, instruments, etc. The endeavor is not science-driven, instead it is answering the innate need to explore for science, security and economic reasons. The underlying reason is helping to rebuild the aeronautics industry in the US. Developing and demonstrating power generation, propulsion, and life support for Mars exploration is a special province of OBPR. This is a commitment to be on-site. How are we to react to the OBPR budget numbers as presented by OMB? What we know we have to absolutely accomplish for the directive is the following:

- Deliver methods and technology to ensure human health and performance off-world.
- Deliver advanced life support systems and technology that are more reliable, capable, simpler to operate, while being smaller, less massive, and more energy-efficient.

We have a very limited time in which to accomplish these things and must rethink how to get there. However, OBPR has much more to offer to exploration in terms of cross-cutting expertise and a good track record in fundamental research, not just in the space program. OBPR also has an ability to deliver Earth benefits, something the public expects. A multiple step process has been initiated to meet the mandate by the end of the summer: Review what's in, what's out/what's new, and review and prioritize the existing research portfolio (all 852 investigations), and propose new high-priority research areas to add to the portfolio, the latter of which requires more substantial changes to the existing portfolio. It is a zero sum game. The technical and financial implications must be considered: estimate changes to flight manifests/queue, changes to the existing MUSS, compare with available resources on ISS, iterate as necessary, and estimate

budget changes to existing program. Dr. Baldwin commented that there is a significant change taking place, leading to the necessity of thinking in mission-directed terms with goals and timeframes- the science community is going to cry about it. There is no doubt that emphasis on fundamental research will diminish, but the mindsets have not changed. Dr. Ross noted the NSBRI is going to have to provide more detail on what it is funding. Dr. Bula remarked that the same will apply to the life support systems. Dr. Oman brought up the topic of artificial gravity (AG)- the problem becomes grave if the shuttle goes away- how do we write the AG requirements? Dr. Ross replied he was not sure how much hardware OBPR will be building if the Shuttle goes away in 5.5 years. Dr. Oman noted that because of the Shuttle problem, Gary Martin can't obtain the answers he wants on AG or other countermeasures. Considering other factors, what does this mean to implementation, acquisition strategy, RPC and center responsibilities, external review, etc? Dr. Gross asked if one may assume that research will be conducted on the Moon. Dr. Ross added that the flight program elements must be approached differently. The cost differentials would make research much more expensive on the Moon (the Moon is 2 to 3-fold more expensive). OBPR must also weigh the ability to satisfy the desire to do fundamental research, honor commitments to partners, PIs and students, retain the interest of the vested/supportive research community, and to obtain near-term return on the station. The last step is to prioritize what is truly affordable, recognize institutional requirements, and required reserves, etc.

Intervening factors are new Enterprises with new roles and responsibilities (ISRU, e.g.). Budget guidelines, due on March 15, must have good fidelity for FY04 and FY05. Decisions must be made immediately. Thus far, OBPR has achieved two cuts at requirements and top-level budget estimates have been made, and has made some progress on technical and financial implications. Debates will be conducted on mission scenarios, schedules, etc. Other factors have yet to be considered. OBPR is looking at a completely new way of planning in terms of Product Lines. What are the deliverables?

Exploration product lines will include human health, human life support, radiation, BPR on the Moon and Mars, and low-gravity research for exploration. Artificial gravity is not in the product line because it is a solution to a problem (a multi-system countermeasure). To study AG, OBPR will need a much broader program. Other product lines and subcategories were described, including EVA systems, *in situ* fabrication and repair, fire suppression and detection, and nutrition, immunology, cardiovascular, and neurovestibular studies. Further categories are radiation shielding and modeling and remote instrumentation technology. There is a real chance to mitigate age-old complaints, create a focus for the ISS. It is a chance to create something new and valuable, and a chance to redefine our future. Dr. Borer remarked that in the time available, it seems one can only deal with a cadre of people who are expert, with tight central control; this implies exclusion of the community. OBPR should be creative and maybe expand its advisory structure to get some community approval; it can't do this with a bunch of RFAs and a finite amount of money. Dr. Ross commented that the ground-based (GB) program has a lot of flexibility in the longer term. Another approach is to have fewer grants and larger grant amounts. Teams are not a good solution because there are favoritism issues. Various approaches are being actively discussed. The Jan Meck colleague-to-colleague model is a good one, but it requires a response to a focused question that does not require considerable (or any) resources. Dr. Gross predicted that NASA will fly the Shuttle beyond 2010 and use the station

beyond 2015. Dr. McPherson questioned the rationale of finishing ISS if it is not intended for research after completion. Dr. Ross countered that ISS is being used to reduce the risk for human exploration and validate GB countermeasures research, and also to meet international obligations. There was a brief debate as to the utility of ISS as a necessary prerequisite to Mars exploration. Dr. McPherson remarked that the current ISS vision seems a ungainly way to exit the ISS era. Dr. Baldwin noted that the budget is very unrealistic, so it is difficult to make any arguments about the logic of finishing the space station to pave the way for exploration.

There are shuttle and ISS extension programs, but certain measures, such as last tanks ordered/produced for Shuttle, are in progress. Dr. Baldwin felt that, based on resources spent to date, the ISS is a logical place to test human factors (as opposed to testing these on the Moon), and is the best use of the available money. Unfortunately, NASA is being forced to make a frameshift mutation when it would prefer an evolution.

### **Discussion**

The driver is obviously money- it does not behoove us to rail about it. The best thing to do is to look at the resources available and maximize output, and look at 2016 later. NASA must deal with priorities because public monies are being spent. The research goals still can be undertaken under the auspices of the international partners. In the analogue to pharmaceutical industry, most drug development is multinational and highly cooperative. That sort of relationship should be sought. The idea of continuing with the ISSRI makes no sense given the new scenario. NASA will make the decision in June. In 2016, the institute might be useful. It might be worthwhile to develop it and then spin it off in the future to a private concern. Directed education in the ground-based program, with graduate students, may be another way to approach research, to build flight investigators of the future. However, it may be too narrowing for students. On the other hand, it can be made into an exciting opportunity for a PhD thesis if the proper resources are made available. Collaboration and team efforts are critical.

It would be valuable to look at the transition as short, medium, and long term. There will be other opportunities post-shuttle and post-ISS. The impact of the compressed timeframe and cost-shifting is high. Can international partners keep certain programs going in the fundamental sciences? The construction period of the ISS is a long one; can NASA take advantage of current facilities to continue projects while transitioning the ground-based and AG projects? There is a smaller-scale ESA centrifuge that will go up soon. The BPRAC can help OBPR formulate the plan through teleconferences to work on action items leading to a new strategy. An unintended consequence of the transition is more cooperation; the life and microgravity sciences researchers are being forced to think like engineers. Goals and deliverables are a different mind set for the life sciences. NASA centers are already forming integrated teams to meet the challenge. Maximal use of scientific community input will become critical as NASA becomes more mission-oriented.

Dr. Kicza presented certificates and tokens of recognition for departing members. Committee member turnover was briefly discussed and Dr. Baldwin announced that he will continue his role as Chairman through 2004, to aid with the transition.

**February 13, 2004**

Dr. Baldwin commented that he would to see a framework for OBPR that would enable a better balance of space biology, physical sciences and bioastronautics.

**Free Flyer Workshop Results**

Ms. Terri Lomax presented the results of a plan to utilize flight experiments to complement the efforts of ISS, and pointed out an increase in publications thanks to Free Flyer efforts. The study has been in work since Jan 2003, and has been a combined effort between Goddard Space Flight Center and Ames Research Center. The study team formulated a scenario for a pair of OBPR free-flying satellites to conduct a range of important experiments dealing with conditions and materials (radiation, pathogens, fixatives, etc.) that are not easily tested on ISS. Once that basis was established, the science community was brought in to validate ideas. A workshop was held, attended by 66 members of the research community, included non-NASA funded researchers. A good cross-section of representation was achieved.

Key capabilities were described for the Space Shuttle, ISS and Free-Flyer missions. Species to be flown would include *Drosophila*, *C elegans*, and plants, with the most challenging life forms being rodents. Current architecture would indicate a ballistic reentry device for recovery of free flyers. Another goal is to develop remote technologies to reduce return of samples. Three main research goals are to seek knowledge of how life interacts with the physical world, expansion of knowledge of the physical world, and the development and validation of innovative exploration technologies. Research activities would include continuous ultralow gravity levels to determine gravity sensing levels in plants and small organisms, study of hazardous species and environments, and radiation effects on cellular and molecular mechanisms (radiation repair and countermeasures). One hundred reference experiments were formulated and categorized into three goals:

Goal A-

Determine the basis of altered immunity, determine responses to galactic cosmic radiation, understand effects of accumulation of volatiles in enclosed spaces, understand biofilms, determine mechanisms underlying physiological adaptation.

Goal B-

New physics, conditions beyond the Van Allen belts, testing Einstein's theories, origins of self organization, models of turbulence and combustion effects.

Goal C-

Harmful microgravity physiological effects, critical crew life support systems, new radiation shielding, development of nutritional and pharmaceutical countermeasures, validate advanced propulsion systems, advanced sensors and autonomous controls.

Participants in the workshop concluded that the Free Flyer program has a significant potential to increase the value of OBPR research and open bold new horizons. Recommendations include the use of a broad range of existing and future craft such as nanosatellites, that are currently under test conditions (10 kg mass), and the development of Code S-style, PI-led, dedicated free flyer missions. The program should start immediately and could utilize opportunities on existing

flights with international partnerships. Dr. Baldwin commented that Free Flyers appears to be a perfect program for helping to maintain balance in OBPR. Dr. Faeth attended the workshop and commented on his experience. He recounted that there was an underlying theme to avoid another ISS-type operation, and to shy away from huge long-term facilities. There was an emphasis on what can be done now, and a favorable opinion of taking advantage of vehicles currently in orbit as soon as possible (near-term and frequent flights). Simple experiments were encouraged. There are operations in the US that can build entire satellite systems for modest cost (low millions). Dr. Borer commented on gravity's influence on life processes; the obvious primary results of such studies would greatly benefit the health of people on Earth. The same goes for combustion studies. These are some of the primary justifications for space programs- the Free Flyer program would be the perfect vehicle. Dr. Wang commented that it is the perfect solution for future experiments for human exploration. One can do proof of principle experiments in such environments and use them as cumulative evidence for putting more complex experiments on ISS. The size of experiments is limited to the 250-300 kg range, depending on the altitude and shape of orbit. The relaxing of the INA would also help interaction with Russians and enable NASA to get on Bion flights by 2006. GSFC has a large experience with this concept and can help guide OBPR. The publication record can benefit from frequent flight opportunities and small-scale experiments. OBPR needs to work out some creative, nontraditional launch solutions. An experiment to consider is a partial gravity environment to determine thresholds of gravity levels on bone loss. These results are crucial for exploration research. Dr. Lomax mentioned that OBPR is looking at some AG (spinning) satellites. There was a brief discussion about how to engage interest from the community as Code U moves into the Presidential initiative- this seems to be a good venue due to the enthusiasm seen at the workshop. It was felt that BPRAC should endorse the program completely, and furthermore push for it now as a pivotal mainstream program that should have started ten years ago. Dr. Faeth was asked to put together a recommendation. Dr. Kicza stressed that the complementarity of FF to ISS must be understood. Is it important enough to dig into current coffers in lieu of dollars to GB initiatives or ISS? Getting a new initiative will be very difficult. The community also has a voice beyond talking to NASA and must use it. Dr. Faeth felt it would not be a hard sell in Congress, but it would take some upfront capitalization to sell it. Dr. Baldwin felt Free Flyers was not just complementary but can play a major role in the new exploration initiative. Dr. Lomax added that it also has the ability to excite the public and contribute to the education Enterprise. Free Flyers will give a quick return on investment in the publication arena, and this premise can help sell the program to OMB based on its stated criteria. Dr. Baldwin agreed to take up the idea with the NAC if that was the opinion from BPRAC. Dr. Fuller commented that Free Flyers is really not a new program; if considered in dollars invested per publication, it is probably one of the less expensive avenues to publication.

The workshop was constrained to strictly domestic review- the Bion is a good opportunity to fly experiments almost immediately (it has flown primates in the recent past and has the ability to spin). NASA should look broadly at both domestic and international opportunities while we build new satellites. Dr. Musgrave noted that NASA must be careful not to derail the community's enthusiasm for ISS. In addition, OMB might question the uniqueness of Free Flyers, although the exploration niche is a valid argument. It is a marketing challenge. Conceptually it needs to be debated in more detail and at higher visibility. Dr. Faeth added that workshop participants felt ISS was a substantial asset, and felt Free Flyers should do things that

cannot be done on station, or out of LEO. The ISS also has no capability to study partial gravity. Dr. Musgrave asked if the centrifuge was not in fact the *sine qua non* of partial gravity. Two members opposed wholesale endorsement of the Free Flyer program to the NAC.

### **Bioastronautics Critical Path Roadmap (BCPR)**

Dr. Guy Fogelman presented the BCPR overview. The roadmap has as its goals management of risk to humans and improving efficiency of support systems. It is based on a 30-month Mars exploration mission, wherein 55 risks have been identified, and 250 critical questions have been defined and prioritized. Risks have been assessed by criteria such as likelihood, etc. BCPR disciplines include human adaptation countermeasures, radiation effects, behavioral health and performance, and advance life support, all of which map roughly to product lines. Next steps will be, using the BCPR framework, to align risks to the Exploration Initiative and Moon/Mars mission, and to identify technological gaps and develop a schedule to address gaps within the necessary timeframe. The next draft is due in March, and will be subject to review by the Institute of Medicine (IOM), the National Academy of Sciences (NAS), and the National Academy of Engineers (NAE). An interim report will follow in 6 months, and a final report in 18 months. The BCPR will also reassess countermeasure validation requirements and strategies, define acceptable risk criteria, and develop operating bands for Moon/Mars. The Chief Health and Medical Officer has undertaken activities to examine such issues as acceptable levels of bone loss. The near-term schedule was briefly reviewed. Over the next six months, the BCPR, countermeasure process and risk assessment criteria will be further refined and focused.

Dr. Baldwin commented that the roadmap architects might want an opportunity to use the LSAS component as a task force. The intent is to pull together small workshop-like teams. The NSBRI is also intimately involved in the process. Dr. Kicza mentioned that in the Summer and Fall of 2002, a panel reviewed the NSBRI's strategic plan and the funding has been put in place. NASA has worked through those problems. Dr. Baldwin commented that the NSBRI is alive and kicking and is moving forward in an aggressive way to align itself with the new initiative. There was general agreement. The BPRAC endorsed the value of the critical path, however a questions concerning its value is understandability, or whether it is presented as top-down or bottom-up. A peer reviewer might find it unintelligible without an executive summary.

Dr. Fogelman noted that the BCPR team is still reviewing these shortcomings and is working to make it intelligible. Dr. Oman commented that the roadmap is presented as a bottom-up activity; the real process is more complicated. The interdisciplinary arguments must continue in order to truly prioritize critical questions, so as not to lose objectivity. Dr. Borer felt the desired outcomes had not been clearly stated and thought the roadmap should explicitly spell out the need for survival, productivity, and viability upon return. One must map problems to the hoped-for outcomes (such as sleep disturbances and productivity). Dr. Wang asked how bioastronautics could assess long-term risk without data on the whole genomic reaction to the space environment. The BCPR is working to ensure that these issues are incorporated in the pathway. Dr. Gross re-emphasized NSBRI's value in countermeasure assessment. Dr. Baldwin felt it was important to get the CPR on the table and to initiate a full court press. BPRAC should recognize and endorse the activity as important to the exploration initiative. The NSBRI status should be presented at the next meeting.

### **NAC Actions for the BPRAC**

Dr. Baldwin gave a brief description of NAC activities and solicited feedback to take to the NAC at its next meeting on March 8-9, and distributed a questionnaire encompassing one identified area of need- how are IT/communications issues incorporated into the overarching structure of the Agency? A cohesive response must be presented to the NAC. This includes the Digital Human effort. Dr. Oman regarded Digital Human as a modeling exercise. The BPRAC requested an action on a briefing. The area of interest could also include obtaining data downlinks, better bandwidth, etc, from ISS. Kathy Johnson (informatics) was cited as a good source of information on the subject. Dr. Kicza offered to take a Code U action to provide food for thought for the committee to take forward. Dr. Baldwin thanked Dr. Borer for his proactive findings and recommendations. His personal observation on the initiative has skewed interest toward the bioastronautics in OBPR; they have a full plate and there is a sense of anxiety about the path forward; a balance must be maintained. Dr. Kicza agreed there was no question that there is too much work to be done in bioastronautics. Notionally NASA has been thinking about what this means and has asked the field centers how they might align. The centers feel we should understand who our customers are (internal NASA, the research community) and what the requirements are, and then align in response. Dr. Baldwin remarked that we are at another juncture where NASA is in flux and felt it was too early to offer concrete advice at this point. Dr. Kicza asked the BPRAC's opinion on the validity of the more managed and directed research approach, without losing sight of the need for fundamental research. The Tucson retreat resulted in the formulation of a multicentered team- they should have a first cut by summer. Telecons are a good, cost-effective way to keep progress visible. Dr. Borer felt that OBPR must adhere to the initiative and that it is clearly working to find an alternative way to meet the needs of the initiative. Dr. Oman commented that there was still anxiety about the lack of science, and that NASA needs to get people off the ceiling. Dr. Musgrave remarked that one of the hopeful words at OMB was sustainable, and this is a good way to maintain good science. Dr. Wang offered the phrase, "functional space genomics." BPRAC members were asked to send their reflections to [kmbalwin@uci.edu](mailto:kmbalwin@uci.edu), whereupon Dr. Baldwin will consolidate comments and return a draft to members. The BPRAC must step back and mull over matters before a final report can be made.

## **Findings and Recommendations**

### **Introduction:**

At the February BPRAC meeting it became apparent that with the President's announcement of a re-born vision for human space exploration, along with the realities of accomplishing such a daunting vision in the context of tight budgetary constraints, that there are many challenges facing OBPR in both the near and distant future. As such, the BPRAC was very much impressed with the unwavering commitment, energy of purpose, and initial strategies that were surfaced by the Associate Administrator, Mary Kicza, in formulating a blue print toward achieving the necessary milestones that must be achieved for maintaining human health and capability to meeting the long term mission objectives of the human-exploration-of-space initiative. Obviously, new priorities along with a well-defined infrastructure must be established by strategically integrating the current leadership and programmatic components of Space Biology, Bioastronautics, and Physical Sciences Research within the OBPR Enterprise. The BPRAC enthusiastically supports the new vision within NASA and is eager to work with OBPR as this

challenging journey unfolds. Since this is a critical time for assessing both the direction and steps that must be taken, the BPRAC stands ready and willing to work with you as you proceed with the journey. Listed below are some observations and recommendations derived from the February Meeting that are relevant to where we go from here.

***OBPR Free Flyer Initiative (to the NAC)***

**Finding:**

BPRAC was presented a report about the results of the OBPR Free Flyer workshop that was held recently at Ames Research Center. This workshop was attended by a large number of scientists, technologists, and engineers from the university community, industry and government. The community members at the workshop were very excited and positively disposed to development of a Free Flyer program to enable experiments that either could not, by physical/environmental constraints or practical financial considerations, be accomplished on existing manned space flight platforms. In particular, activities for the free flyers would involve experiments that could not be conducted on a human-inhabited platform, due to safety concerns, or due to the need for a long duration, very low vibration environment. In addition, certain studies require a high altitude elliptical orbit to study the charged particle environment and its effects on biological systems as the orbiter transitions through the Earth's magnetosphere. Other studies require orbits beyond the Van Allen belts to validate the exploration technologies designed to make human travel beyond LEO safe and effective. Where safety precludes using Shuttle or ISS to study physical and biological systems in partial gravity, free flyers can fill that capability. The proposed Free Flyer platforms would open bold new horizons for future OBPR research.

**Recommendations:**

1. BPRAC strongly endorses the findings of the Free Flyer Workshop that Free Flyers offer significant opportunities for enhancing this productivity, quality and impact of NASA research into the areas of interest to OBPR.
2. OBPR should study the implications of a free flyer program, and develop a plan for a free flyer program and associated ground-based research, to provide scientific information relevant to long-duration exploration of space and for understanding of terrestrial biology, and health not available from the low Earth orbit of the ISS.

**Transition plan for de-prioritized investigative teams (Borer)**

**Finding:**

The President's recent announcement of a new specific exploration vision, within a fixed budgetary envelope, will lead to a reprioritization of research, inevitably ending several already approved or even ongoing research projects. Sudden loss of funding support can be expected to impact negatively and in some cases, drastically, on the viability of approved programs. Irrespective of issues of fundamental "fairness," this situation carries potential for disaffection of a substantial portion of the community, and loss of important skills, that will be needed to support future fundamental and applied research, including research ultimately needed to enable exploration. As a corollary, rapidity of response required by the President's initiative may preclude project allocation according to traditional NRAs with their relatively long intervals between announcement, award, project initiation, and completion. This situation argues for the



use of existing expertise, directly controlled by NASA. This may result in a relatively small cadre of NASA-based investigators, limiting involvement of the external community, with important implications for maintenance of the external research community.

**Recommendations:**

1. NASA must develop a transition plan that accounts sensitively for the impact of reprioritization on the affected external scientific community. This plan specifically should envision the possibility of reorientation of approved projects or utilization of approved investigative teams in alternative projects to be consistent with the new priorities and to modulate loss of funding to affected programs.
2. OBPR must develop plans envisioning new relations between external experts and NASA researchers to maintain involvement, interest and support, perhaps involving advisory stipends, or membership on prearranged multi-institutional or multinational teams.
3. OBPR should report progress on such transitioning strategies to BPRAC at its next meeting.

**OBPR Advisory Subcommittee Structure**

**Finding:**

OBPR has undertaken a review of advisory subcommittee structure. This already has resulted in concluding the tenure of one subcommittee, continuation of two others, and suspension of the remainder, pending decisions regarding their future. However, OBPR goals and strategic imperatives will change rapidly in response to the recently announced Presidential vision for space exploration. To date, subcommittees generally have focused on oversight of broad areas during extended intervals. However, in an environment of rapidly changing priorities and strategic goals, advisory structure supporting BPRAC may be most effective if oriented toward review and solution of specific, time-sensitive strategic problems. Thus, except regarding well-defined areas where ongoing oversight is particularly effective (at present, SSUAS and CAS), subcommittees might best be organized as task forces, charged for a limited time to resolve specific concerns, and including a varying cadre of persons encompassing relevant expertise. From this concept, it follows that it is not necessary to establish a set of standing committees other than SSUAS and CAS at this time.

**Recommendations:**

1. OBPR should develop an advisory structure plan that envisions an organization of task forces, on an interim, as-needed, basis, to resolve time-sensitive strategic issues, and should establish standing subcommittees when their need is clearly manifest.
2. OBPR should report its progress to BPRAC at its next meeting

Meeting Attendees

Bernie Seery/NASA  
Karen Blynn/NASA  
Brad Carpenter/NASA  
John Bartoe/NASA  
Susan Wilson/Teledyne Brown Engineering  
Craig Seabrook/Teledyne Brown Engineering  
Tracy Gifford/NASA-Code B  
John Cox/CSC  
Ray Askew/Texas A&M  
Michael Wargo/NASA  
Robert Phillips/CSC  
Nicholas Bigelow/University of Rochester  
Mary Musgrave/University of Connecticut  
Eugenia Wang/University of Louisville  
Ken Baldwin/University of California at Irvine  
Alex McPherson/ University of California at Irvine  
Marc Shepanek/NASA-Code Z  
Ronald Leung/NASA-GSFC  
Al Lieberman/NASA-GSFC  
Frank Szofran/NASA-HQ  
Leroy P. Gross//Inomedic  
Charles M. Oman/Massachusetts Institute of Technology  
Donna Shritz/NASA-HQ/M-I  
Bonnie McClain/NASA  
Patti O'Donnell/Hamilton Sunstrand  
Ellen Stigberg/NASA  
Marc Timm/NASA  
Russ Bardos/SpaceHab  
Charlie Stegemoeller/NASA  
Jeffrey R. Davis/NASA  
Naser Saiyad/NASA  
Gene Trinh/NASA  
Don Thomas/NASA  
Mark Lee/NASA  
Bruce Hather/NASA  
Judith Robey/NASA  
John Emond/NASA  
Terri Lomax/NASA  
Louis Ostrach/NASA  
Volker Kerm/NASA  
Merrill K. King/NASA  
Gregory K. Dees/NASA-Code U  
Elizabeth Gonzalez/NASA  
Frank Schowengerdt/NASA  
Angie Lee/NASA

Orlando Santos/NASA  
Howard Ross/NASA  
Vita Cevenini/NASA  
Jeffrey Borer/Cornell Medical College  
Steve Papagiotes/University of Florida  
Steve Davison/NASA  
Jonathan Root/NASA-HQ  
Chris Shank/House Science  
John Minikakos/House Science  
Mary Kicza/NASA  
Joanne Hopkins/SRI International  
Peter Ahlf/NASA-Code UM  
David Tomko/NASA-Code UB  
Betty Sigil/NASA-HQ  
Carl Guastaferrero/InDyne  
Lance Bush/NASA-HQ  
David Larson/NASA-HQ/Code UM  
Gerard Faeth/University of Michigan  
Tom Doby/US Navy  
Chuck Fuller/University of California at Davis  
Sandra Gahan/National Research Council  
Mary Snitch/Lockheed Martin  
Lisa Vandemark/National Academy of Sciences  
Ray Bula/retired  
Elaine Akst/NASA

***Materials Presented***

1. Report to the Biological and Physical Research Advisory Committee- Bradley M. Carpenter
2. Office of Biological and Physical Research Program Overview- Mary Kicza
3. A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration
4. ISS Research Status: Briefing to the BPRAC- Donald A. Thomas, Ph.D.
5. International Space Station Research Status: Implications of the President's Vision- Peter Ahlf (presented by Donald Thomas)
6. OBPR Next Steps
7. OBPR Free Flyer Research Workshop
8. Exploration Initiative and the Bioastronautics Critical Path Roadmap- Guy Fogelmann

***Materials Distributed***

1. Physical Sciences Research Division: Recent Program Highlights
2. Space Product Development
3. Biomedical Program Highlights
4. Biological and Physical Research Enterprise Strategy
5. Space Research, Winter 2003, Vol. 3, No. 1.